
Vision Series: Power Management

Offline Power Conversion

STMicroelectronics



Power Management



Five Years Out

Power is needed everywhere

Home appliances Home automation Industrial Consumers Lighting Energy meters Adapters Electric Vehicles

Non-isolated
flyback or buck



buck converter



flyback
or buck



flyback



flyback
or buck



flyback
or buck



flyback



flyback
or buck

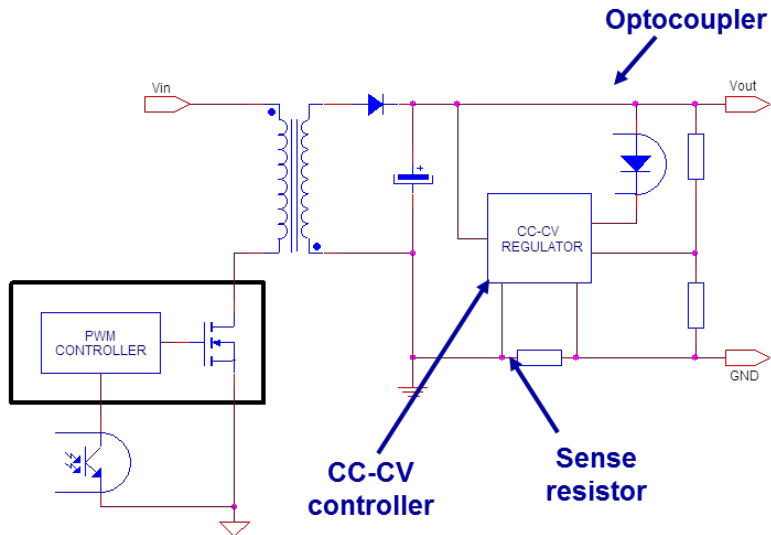


How to select the right power supply?

- **Regulatory requirements:**
 - Power factor : EN61000-3-2
 - Not required for power supplies <75 W
 - But, required for all lighting equipment
 - Safety : UL 1310 Class 2: isolation, output <60 V DC
- **Application requirements:**
 - Constant voltage (CV) or constant current (CC) output
 - Isolated or non-isolated
 - Power, size
 - Other: efficiency, cost, etc.

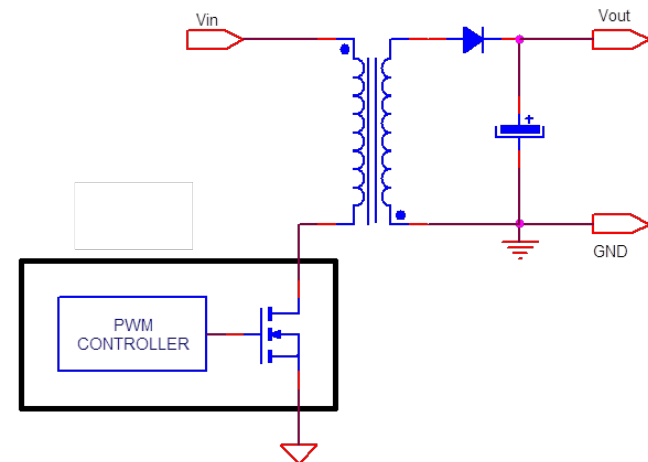
Flyback: Two Architectures

Standard



- Need sense resistor
- Need dedicated CC-CV controller
- Need opto-coupler

Primary Regulation



- No need for any secondary sensing, CC-CV controller, or opto-coupler
- Control of output voltage and current entirely from primary side

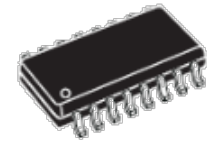
Control methods: PWM or Quasi Resonant (QR)

- PWM control:
 - Fixed switching frequency operation
 - Electro-magnetic Interference (EMI) of the switching noise tends to be more concentrated in a narrower frequency range (frequency jittering can help)
 - Discontinuous Conduction Mode (DCM)
 - Switched currents go to zero before the next switching cycle begins
 - The switched current peaks are typically higher than those of QR control
- QR control:
 - Variable switching frequency operation
 - Spreads the Electro-magnetic Interference (EMI) switching noise out over a wider frequency range than does a fixed switching frequency (without jittering)
 - Boundary mode or Transition Mode (TM) operation
 - Works at the boundary between DCM and Continuous Conduction Mode (CCM)
 - The switched current peaks are typically lower than with PWM control
 - Light-load switching frequency can be very high

Two Approaches: Integrated or Discrete

- **Integrated:**

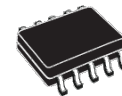
- Controller and HV MOSFET in same package
- Fewer external components
- Ideal for low power ($< 20\text{ W}$) applications



VIPer and
ALTAIR
Families

- **Discrete:**

- Controller and HV MOSFET in separate packages
- More external components
- High power handling capability
- More flexibility



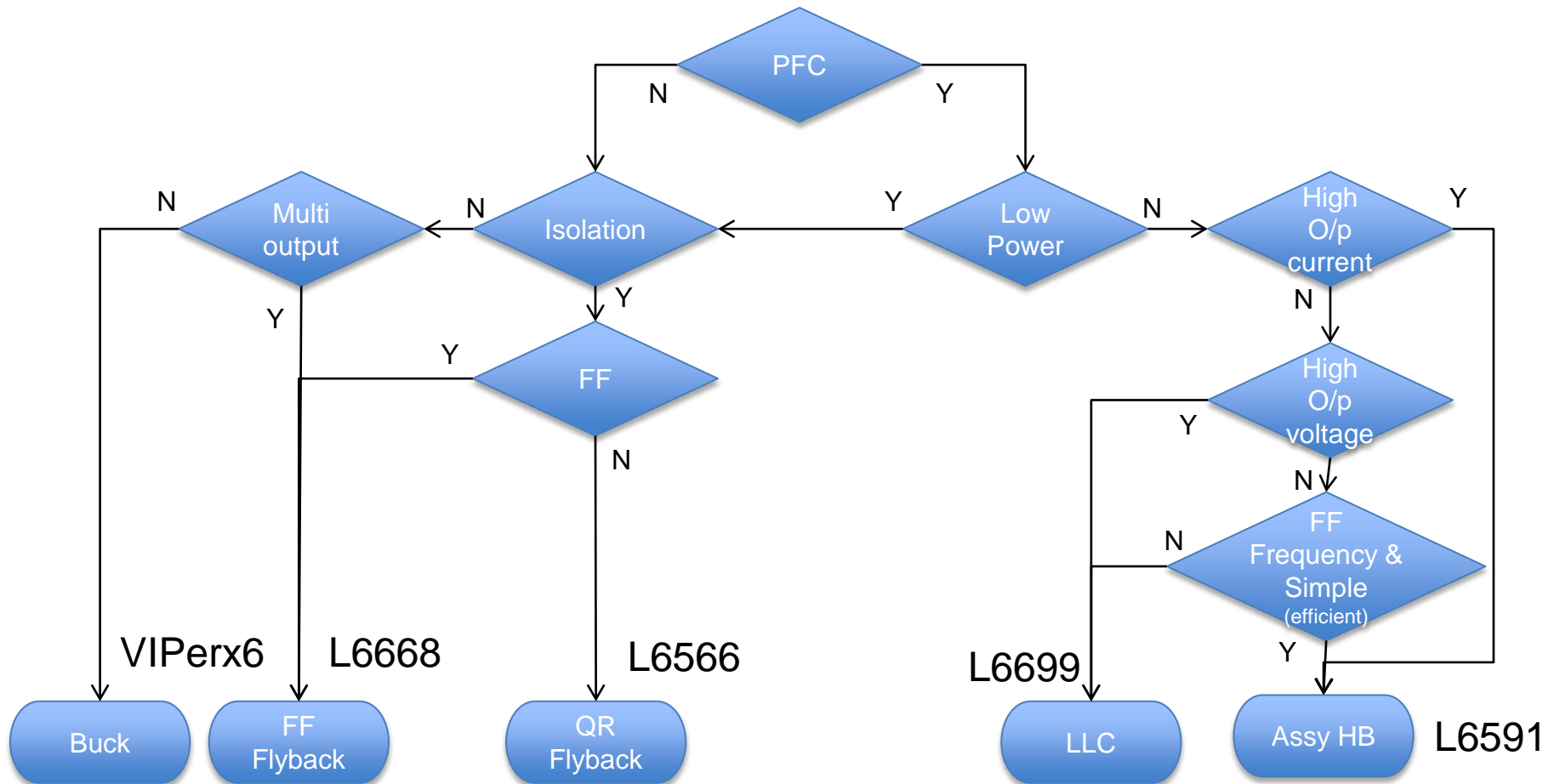
L6565
or L6566

+



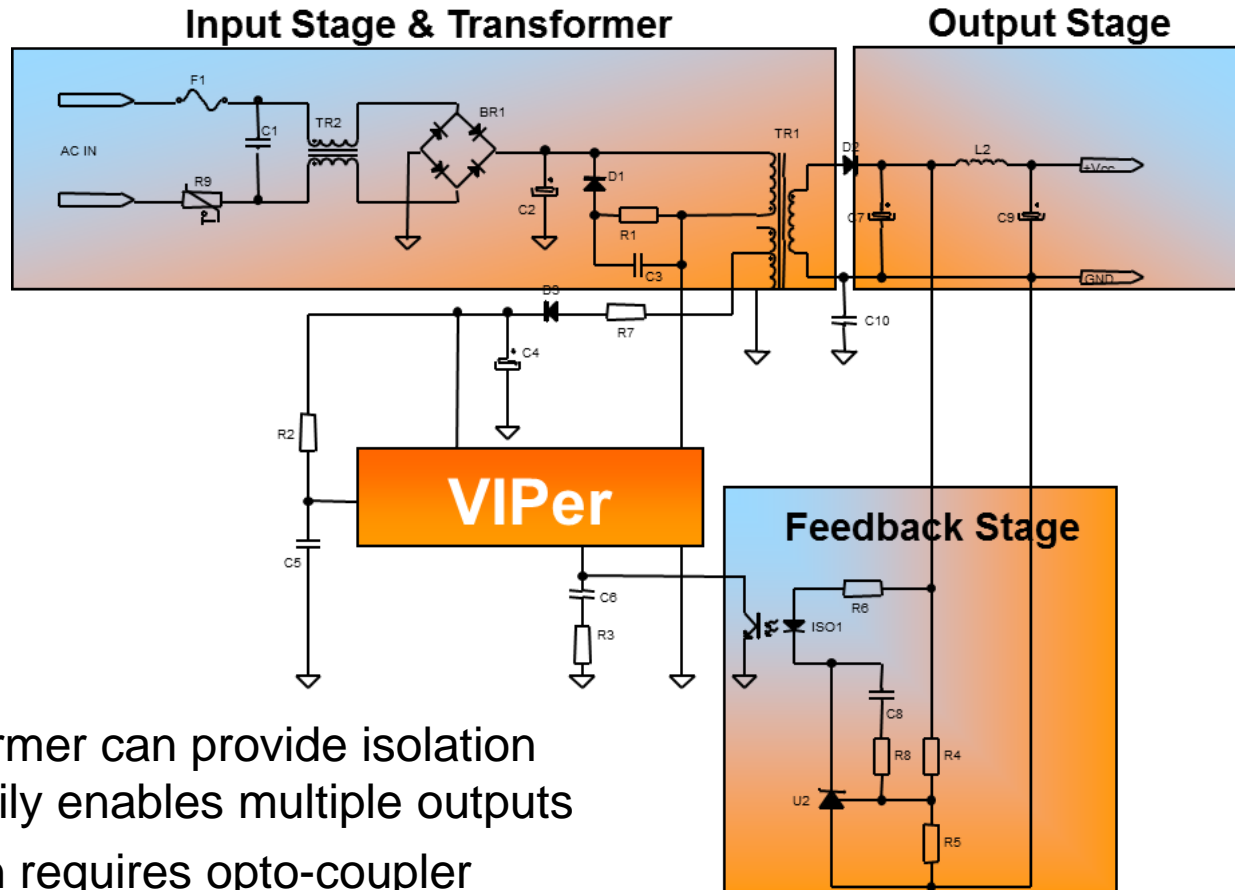
MOSFET

Offline Power Supply Decision Chart



Power supplies without Power Factor Correction (PFC)

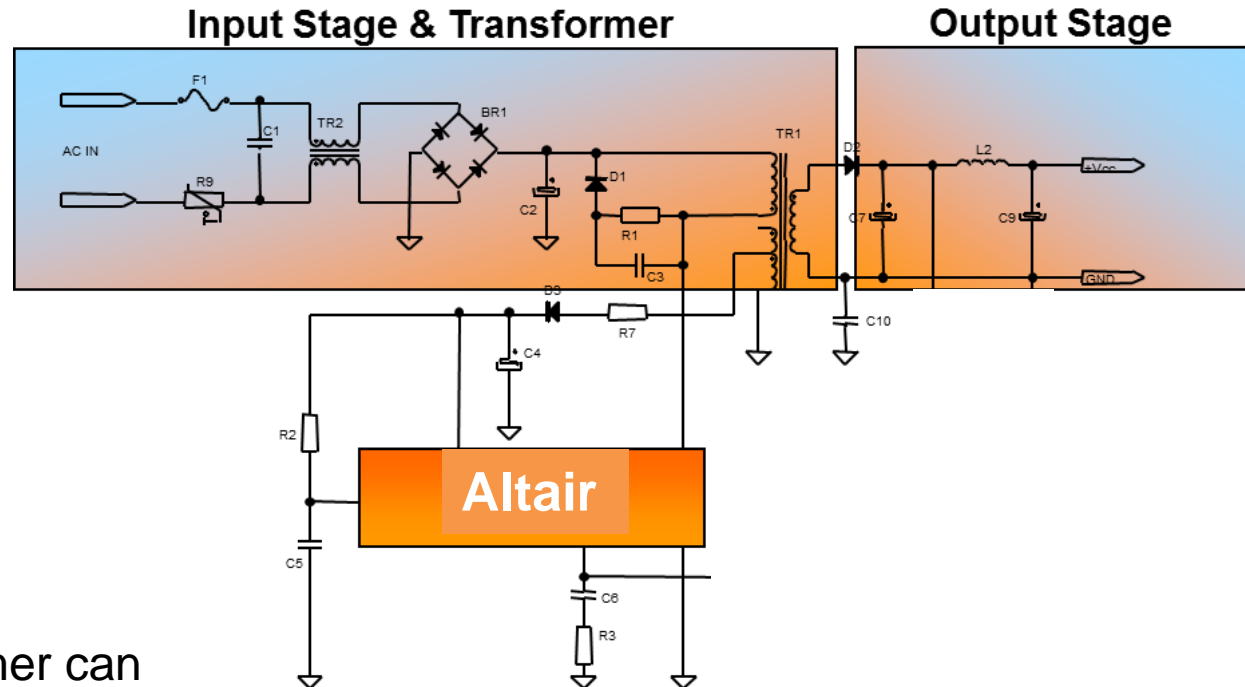
Low power flyback with standard feedback



- **Flyback**

- Transformer can provide isolation and easily enables multiple outputs
- Isolation requires opto-coupler based feedback

Low power flyback with primary regulation

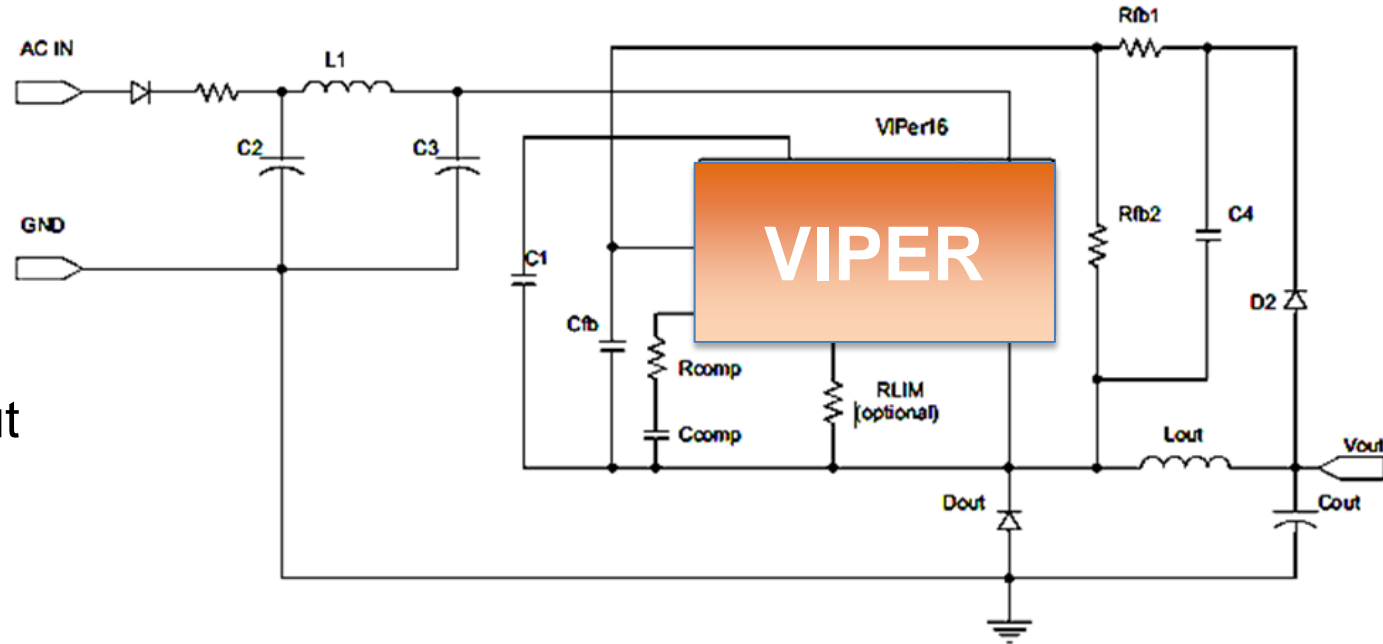


- **Flyback**

- Transformer can provide isolation
- No opto-coupler required!
- Only one output

Simple Buck

- Simple
- Low cost
- No isolation
- Only one output



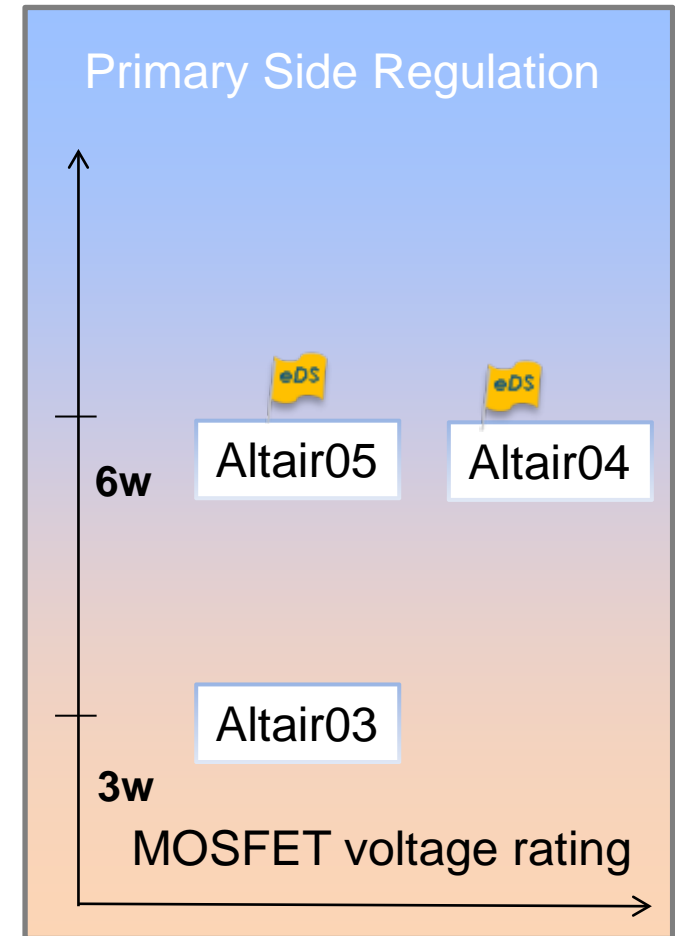
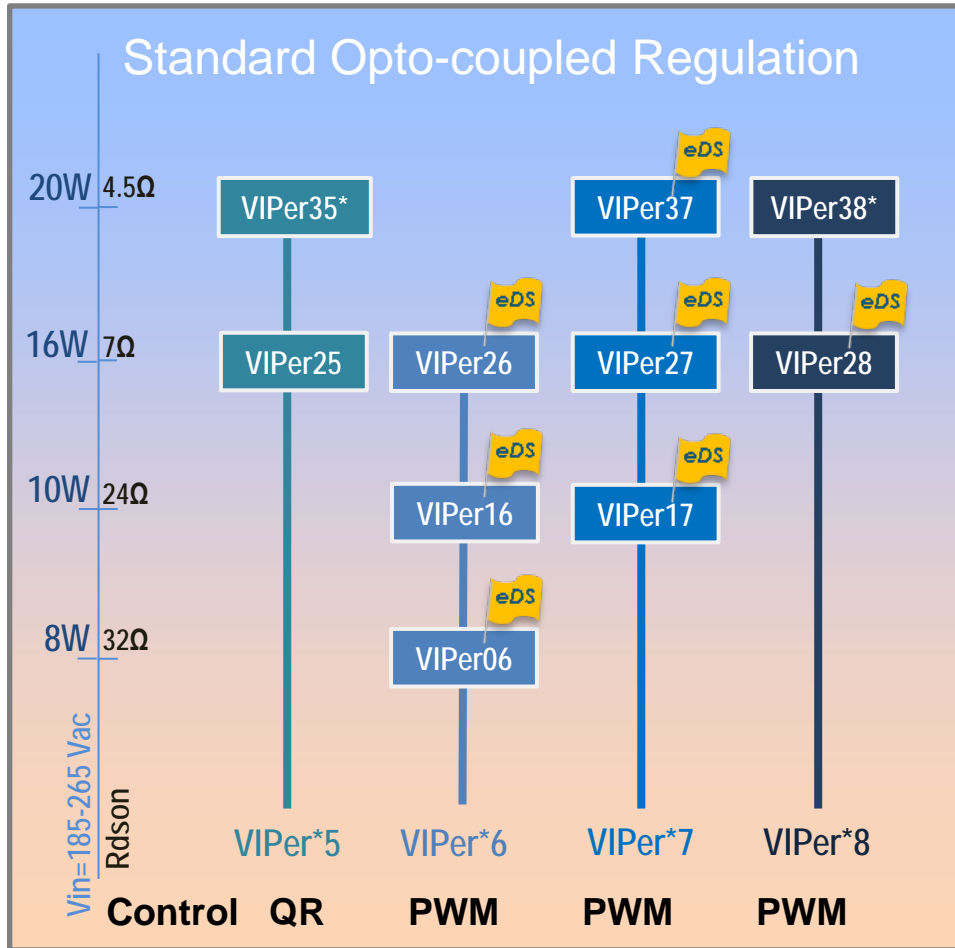
The output current is determined by the current limit of the VIPer device:

VIPer06: $I_{out} < 150 \text{ mA}$

VIPer16: $I_{out} < 250 \text{ mA}$

VIPer26: $I_{out} < 400 \text{ mA}$

Wide options for integrated solutions



(*) Available in Q3



Power Management

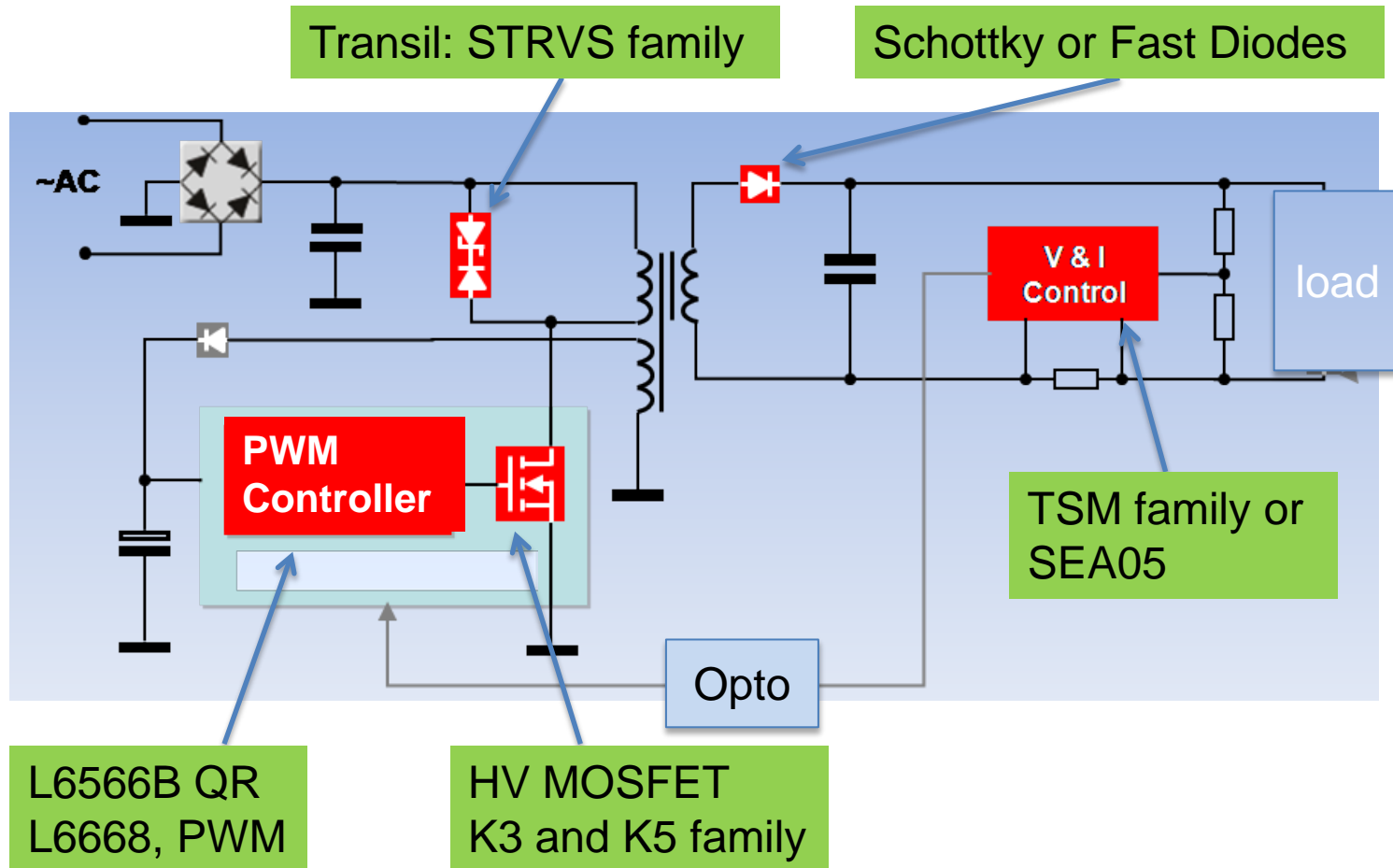


eDesignSuite supported



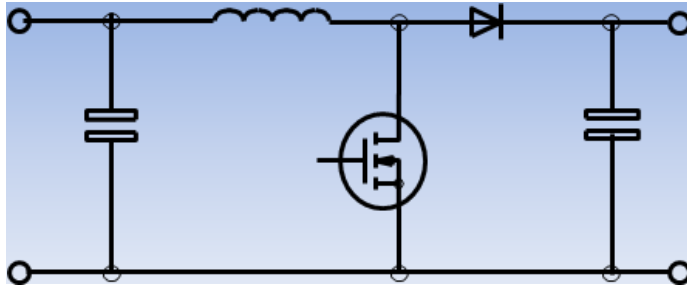
Five Years Out

Solutions for Flyback Converters >20 W



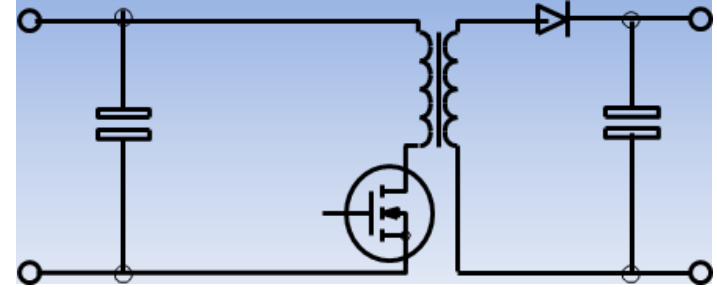
Power supplies with Power Factor Correction (PFC)

PFC Power Stage Topology Choices



BOOST

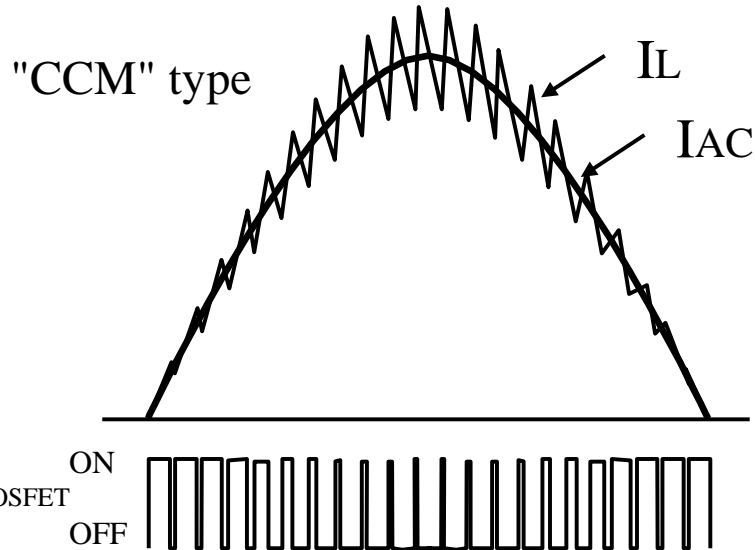
- **Pros**
 - Can achieve high Power Factor
 - Low EMI because of Boost inductor
 - Switch breakdown voltage = V_{out}
 - Immune to input voltage surges because of bulk capacitor
- **Cons**
 - Cannot control if $V_{in} > V_{out}$
 - Cannot limit short circuit current
 - Non-isolated converter



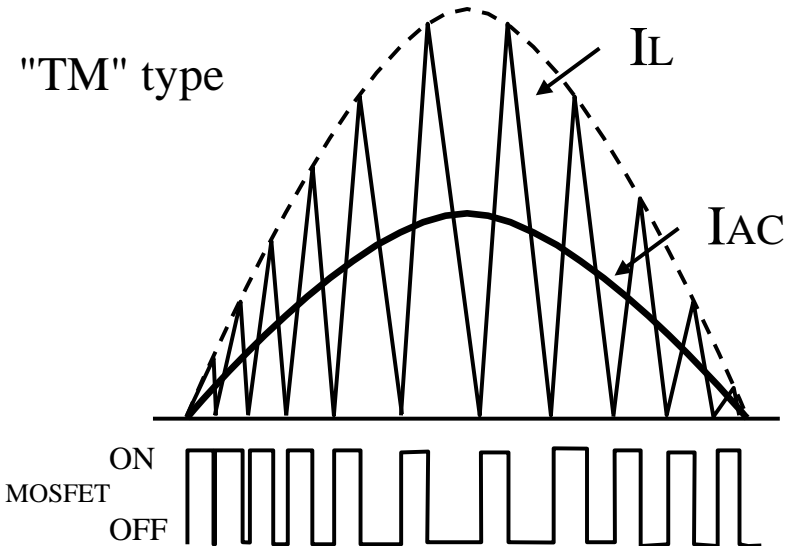
FLYBACK

- **Pros**
 - Can achieve high Power Factor
 - V_{out} can be higher or lower than V_{in}
 - Can limit short circuit current
 - Transformer can provide isolation
- **Cons**
 - Chopped input current, higher EMI
 - Transformer costs > boost inductor
 - MOSFET breakdown voltage is high: $> V_{pk} + n \cdot V_{out}$

PFC Operation Modes: CCM or TM



- Fixed frequency, duty cycle modulation
- Continuous conduction mode: I_L only falls to zero at AC zero current crossings
- Average current mode control is more complex: high performance, but higher cost
- Suitable for higher power levels (>300 W) approximately

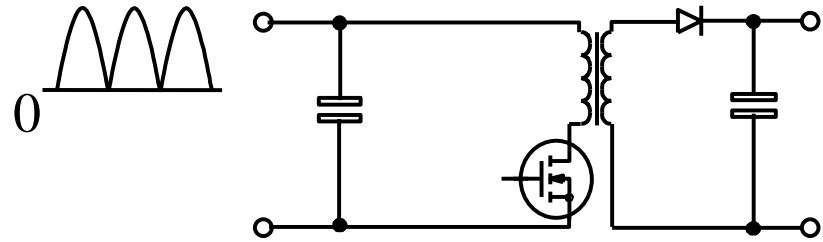


- Variable switching frequency, constant T_{ON}
- Operates at the boundary between CCM and DCM (called Transition Mode, TM)
- Peak current mode control is simpler and lower-cost
- Suitable only for lower power levels (<300 W) approximately

Single Stage or Two Stages?

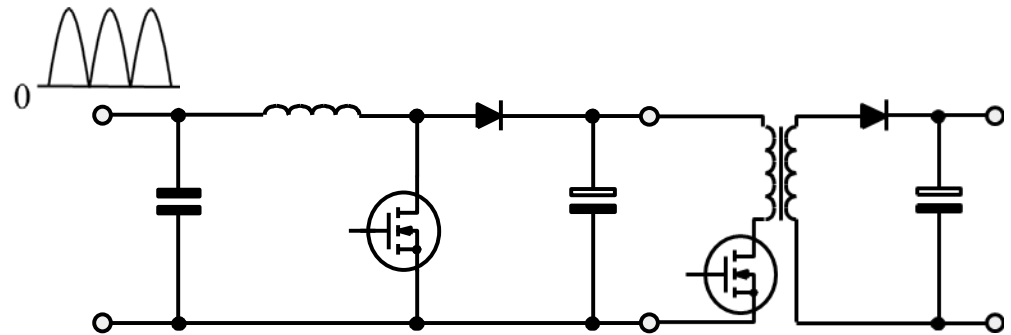
Single stage:

- flyback
- low cost
- poor dynamic
- typically used for $<60\text{ W}$



Two Stages:

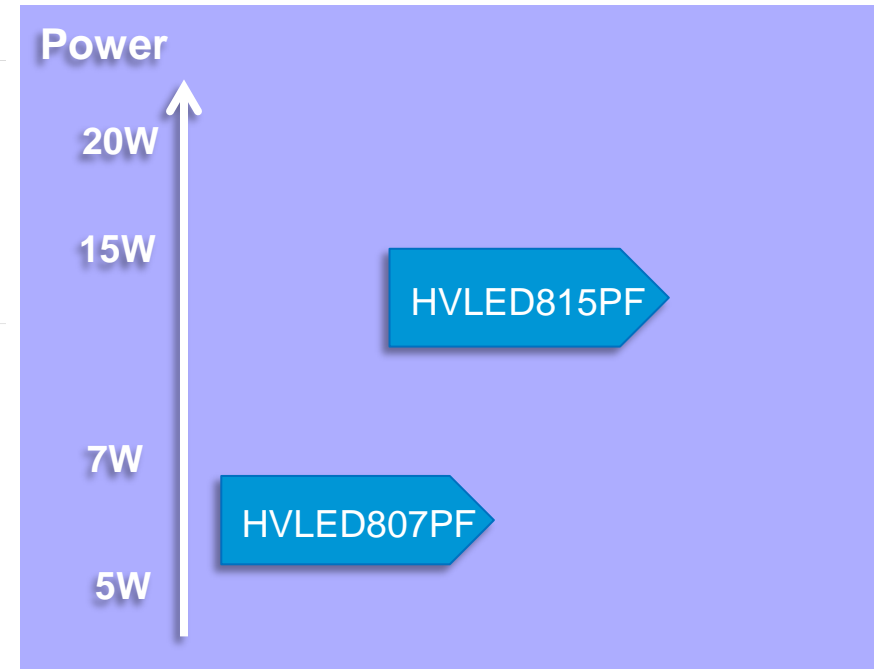
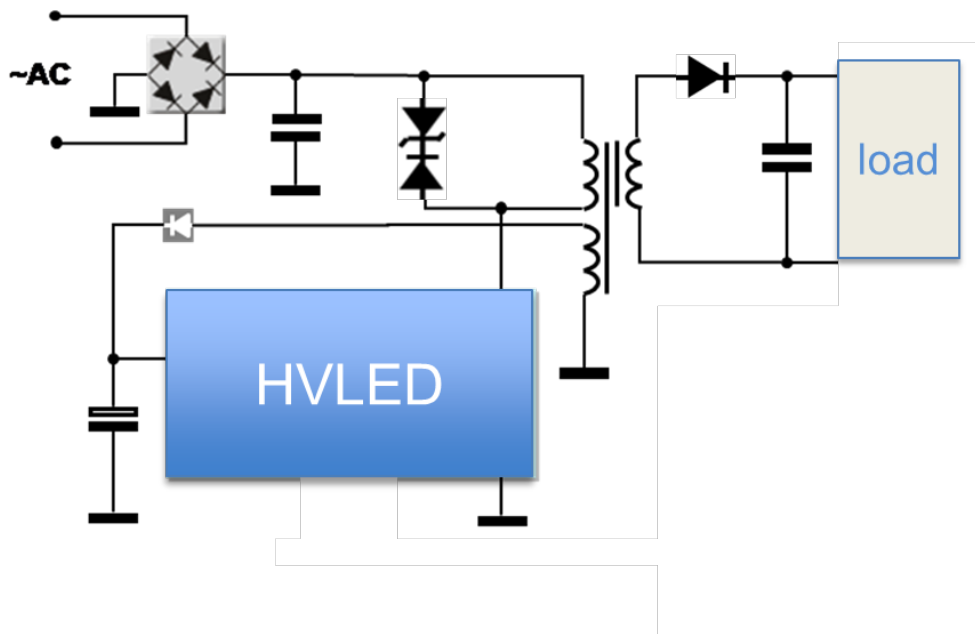
- boost + flyback or boost + LLC
- more expensive
- good dynamic
- typically used for $>60\text{ W}$



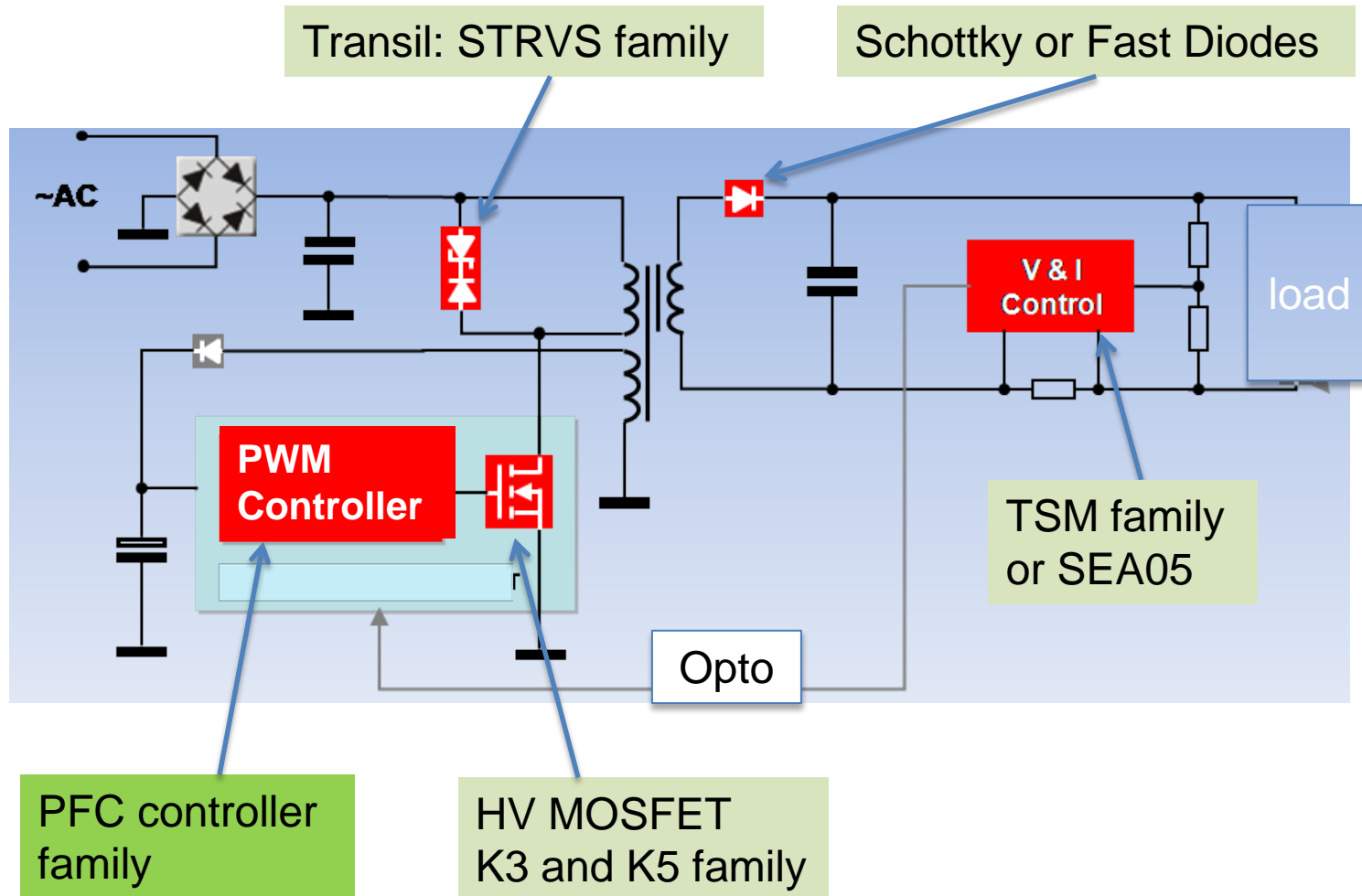
Single Stage PFC Flyback: Primary Regulation vs. Standard Feedback

- **Primary Regulation** (no opto-coupler):
 - Lower component count, smaller size, lower cost
 - Lower accuracy:
 - $\approx \pm 2.5\%$ constant voltage accuracy
 - $\approx \pm 5\%$ constant current accuracy
- **Standard Feedback** (with opto-coupler)
 - Higher component count, larger size, higher cost
 - Higher accuracy: within $\pm 2\%$ for both voltage and current

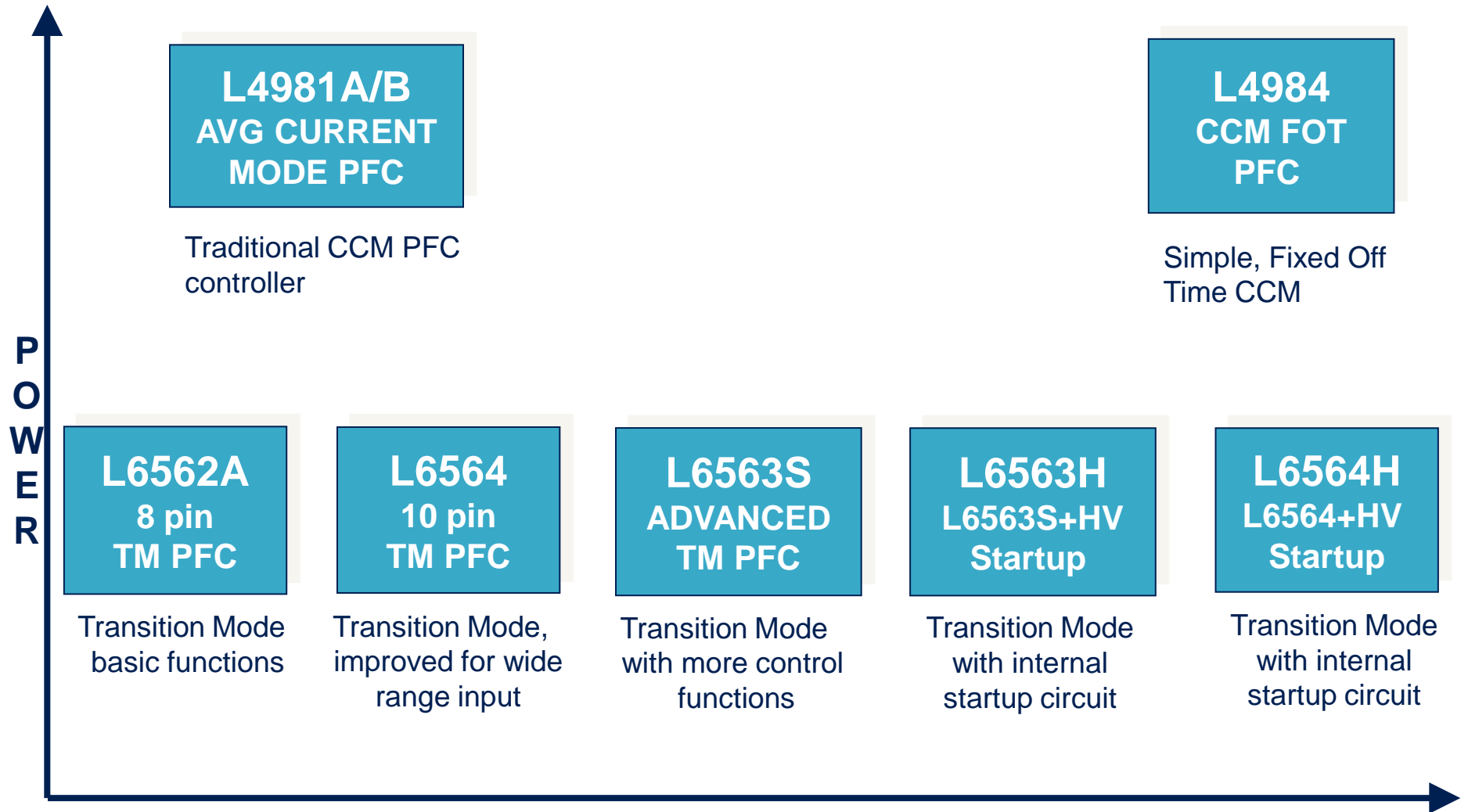
Primary Regulation Single Stage PFC Flyback: HVLED Family



Flyback Solutions for $>15\text{ W}$



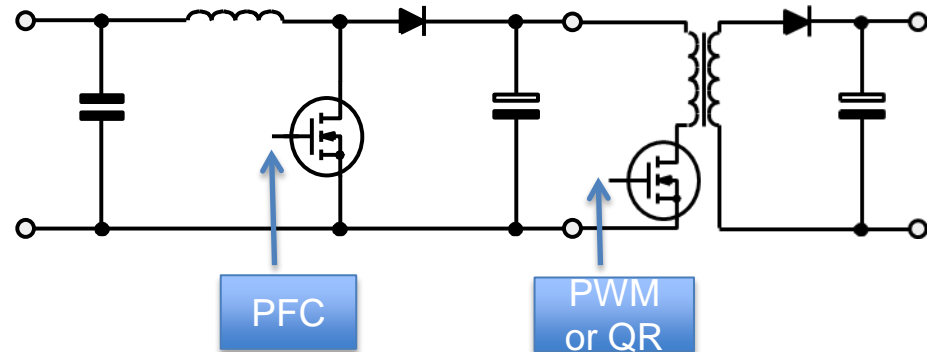
PFC Control IC Portfolio



Two Stage Converters: PFC & 2nd Stage

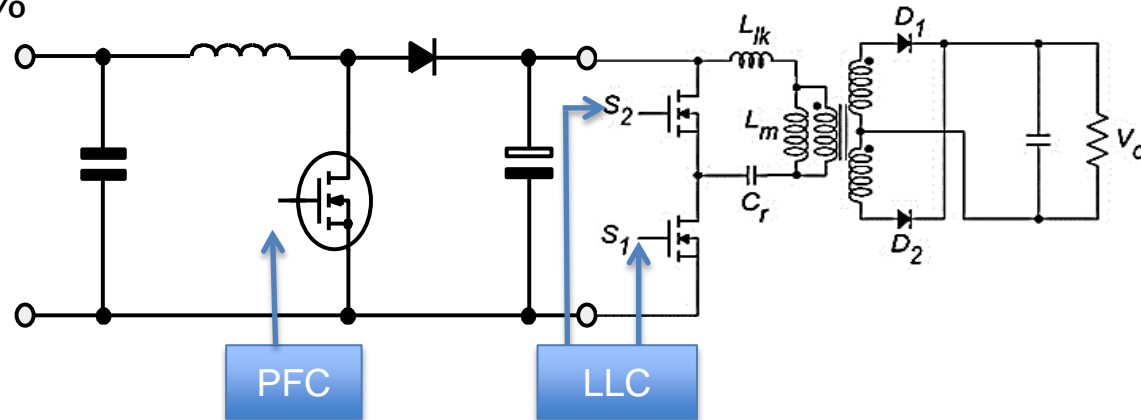
60 W < Power < 100 W: PFC boost + flyback

- Efficiency is good : ~ 85%
- TM PFC & Flyback are easy to control
- lower cost than LLC



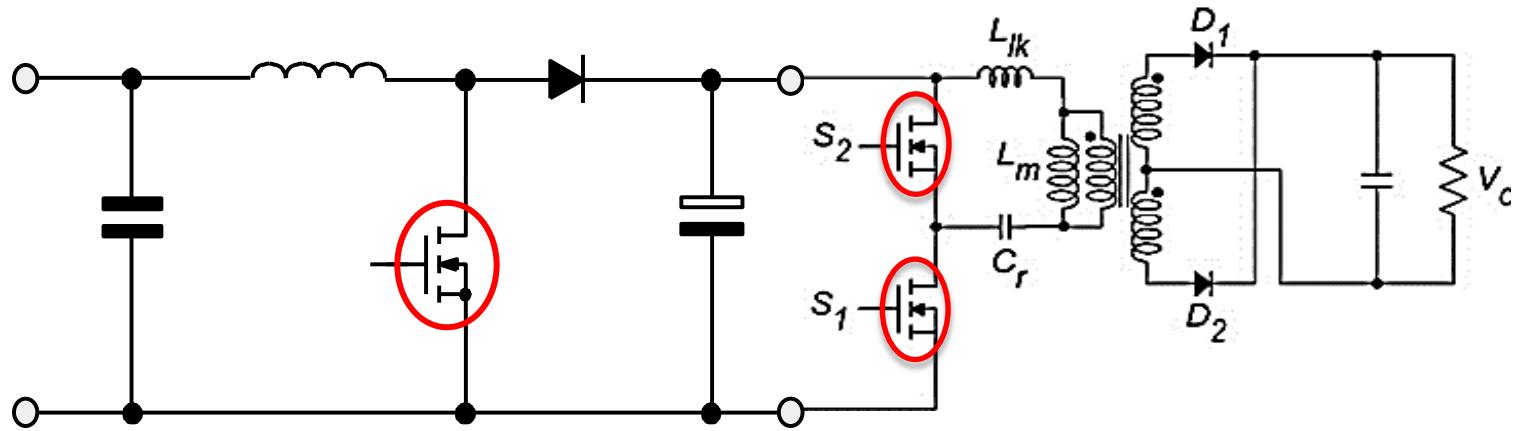
60 W < Power < 500 W: PFC boost + LLC

- Efficiency is very high > 90%
- CCM PFC & LLC control are both more complex
- higher cost than flyback



MOSFET selection for medium power

60 W < Power < 500 W: PFC boost + LLC



- In PFC stage, current is high and conduction losses dominate. Choose low $R_{ds(on)}$ MOSFET from MDmesh V or MDmesh II Super-junction families
- In LLC stage, current is low and switching losses dominate. Choose from MDmesh II low Q_g or fast diode MDmesh Super-junction families

High Voltage MOSFETs

Discover our Products

- Full range of product from 300V to 1500V
- New technologies for state of the art products
- Leadership in Industrial Market



UPS



Lighting



Solar Inverters

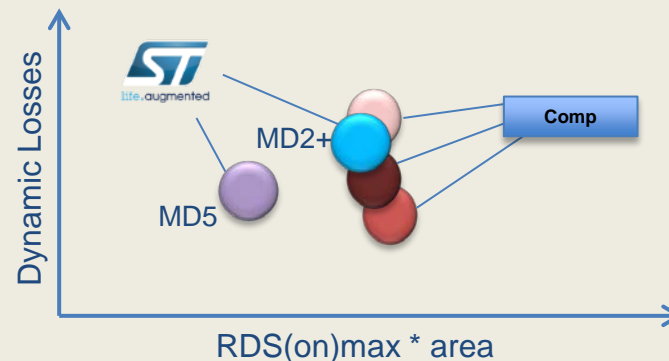


Power Supplies

and many more...

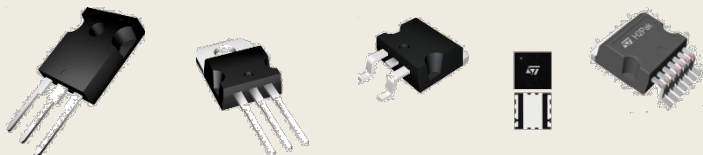
ST Positioning

New 600V Technologies for better Products

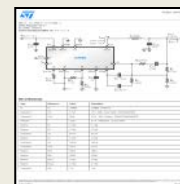


Why ST HV MOSFETs?

- Best performance/cost ratio in the market
- Superior switching performance
- Obliterating competition in 900V and above
- Multiple package options for extended design flexibility



Design Support



Application Notes



Simulation Tools



Evaluation Boards



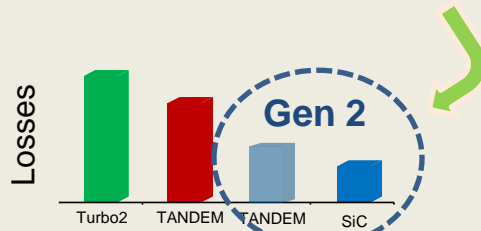
Design Reference

System Knowledge

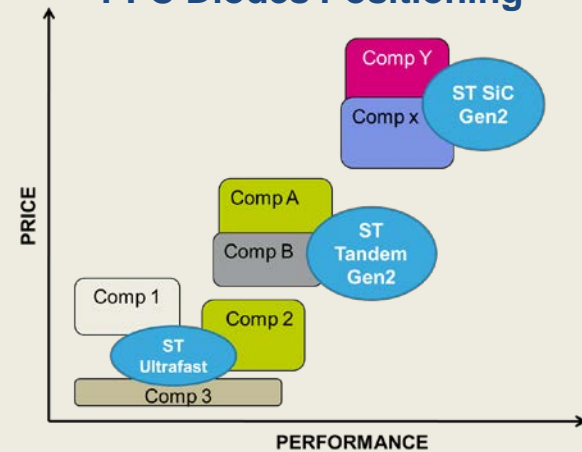
25 Rectifiers

Discover our Products

- Power Schottky diodes
- FERD: “the game changer”
- Super Power ISOTOP
- Gen 2Tandem 600V Hyperfast
- Gen 2 SiC 650V



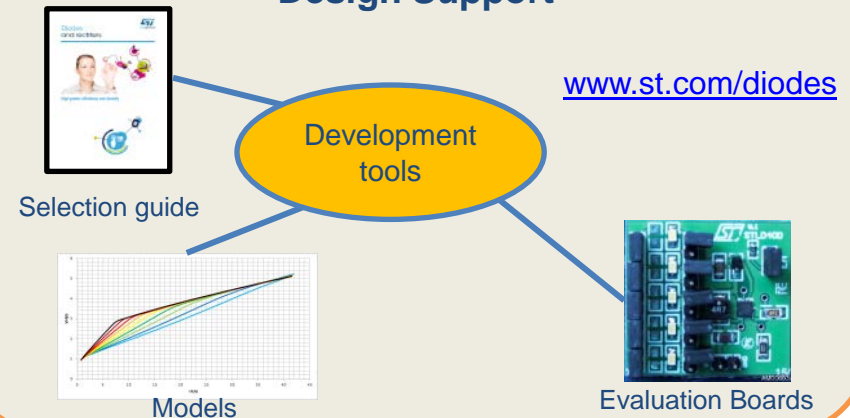
PFC Diodes Positioning



Why ST Rectifiers?

- Power Schottkys → more power, better cost
- FERD → “Game Changer” losses and EMI.
- Gen 2 SiC → Highest peak power in SiC
- Gen 2 Tandem → Like SiC, but at a budget
- ISOTOP → 100 A for Welding

Design Support



Summary

- Select the right topology to fit you application
- ST has a wide range of products to provide the best solutions



eDesignSuite



Power Management



Five Years Out

28 eDesignSuite Creates your Solution



eDesignSuite

The smart tool to design your application

Power Supply
DC/DC - AC/DC



LED Lighting
DC/DC - AC/DC



Photovoltaic
DC/DC



Battery Charger
AC/DC



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Choose an application type
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Insert your I/O specifications and
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A complete design in a few steps



Power Management



Five Years Out

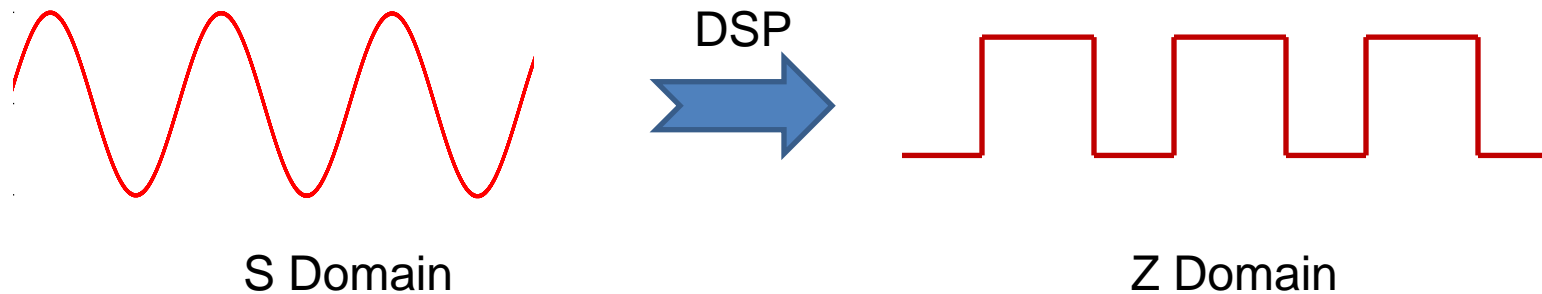
Digital Power Control

Why Digital?

- Advanced control is only possible through digital, non-linear control, step control and self-tuning
- Flexible to reprogramming, upgrade
- Smart functionalities, monitoring, communication
- insensitive to environment (temp drift, offset)

Re-thinking Digitizing

Classic digital control: Digitizing the entire analog signal

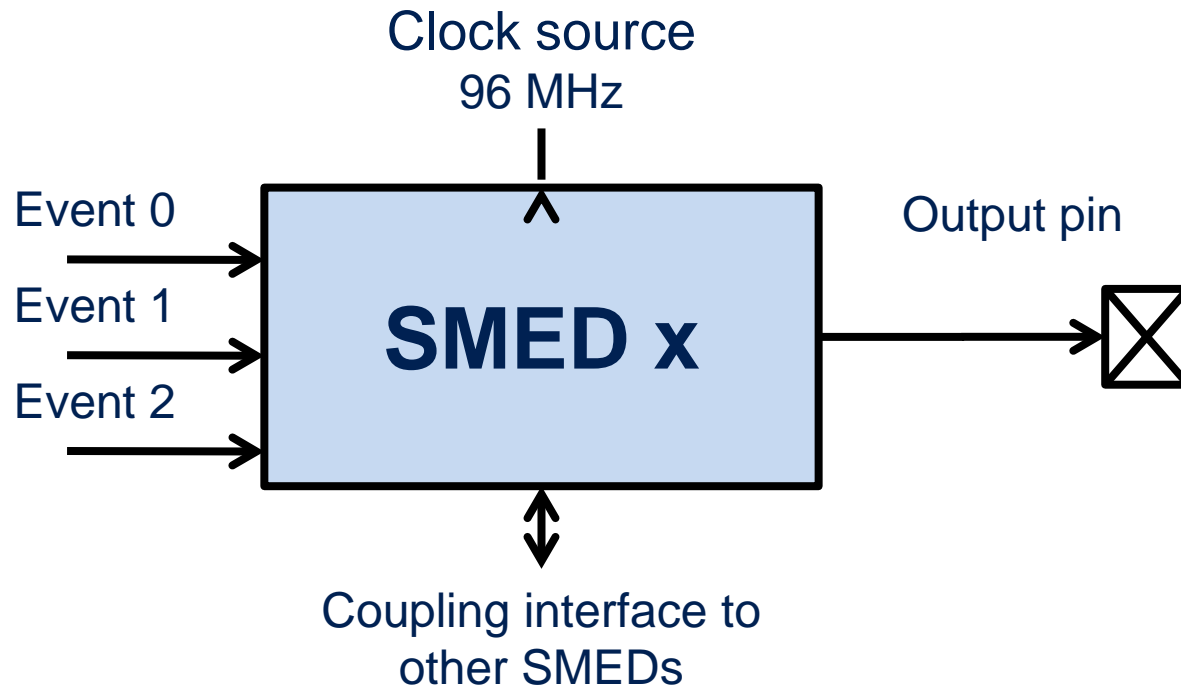


Different approach: State machines

Is it over a current threshold?
Is it over a voltage threshold?
Was a timer limit reached?

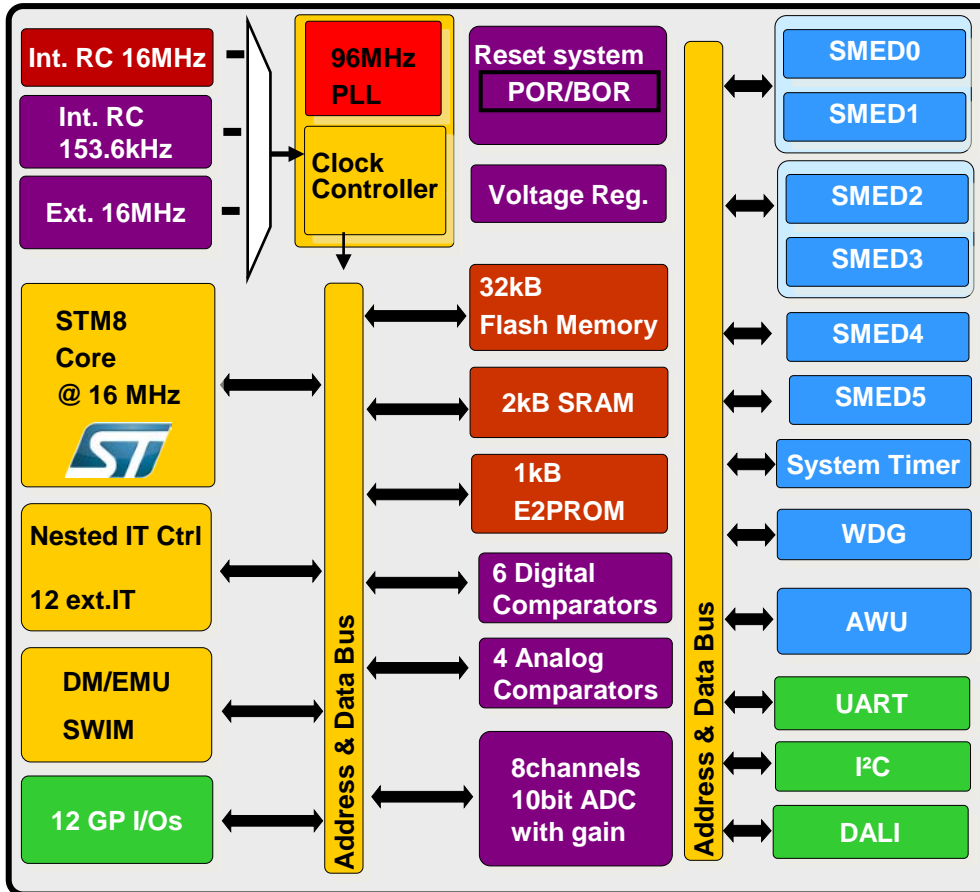


State Machine Event Driven(SMED)



The SMEDs can generate complex pulse width waveforms without CPU intervention

STLUX385A Block Diagram



- Low cost, STM8 8 bit micro-controller
- Six SMEDs
- Four Analog Comparators
- Six independent Digital Comparators synchronized with 96 MHz clock
- Dedicated communication ports

Advantages of ST Digital Approach

SMED

- ✓ Ability to generate complex pulse width waveforms without CPU intervention
- ✓ Very fast: necessary for good power control
- ✓ Highly programmable and very flexible
- ✓ Extensive fault handling capabilities

MICRO

- ✓ Ability to dynamically adjust control loops and to implement predictive algorithms

- ✓ Bi-directional communication
- ✓ Power supply monitoring

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Power Management

Power Management

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- Battery Management ICs
- DC-DC Switching Converters
- Display Supplies and Controllers
- Hot-swap power management
- Intelligent Power Switches
- LED Drivers
- LNB supplies
- Lighting ICs
- Linear Voltage Regulators
- MOSFET and IGBT Drivers
- Motor Driver ICs
- Photovoltaic ICs
- Power Over Ethernet ICs

Resources

Documentation

- Application Note (324)
- Application Presentation (1)
- Brochure (12)
- Flyer (34)
- Product Presentation (14)
- Technical Note (3)
- User Manual (43)

Models and Symbols

Publications

Software

Hardware

As one of the world's leading suppliers of both integrated and discrete power conversion semiconductors, ST's power management devices enable energy-saving, high-power-density and lower-standby-power design solutions. Our product portfolio includes highly-integrated AC-DC converters, switching DC-DC converters, linear voltage regulators, battery management ICs, LED drivers, photovoltaic ICs, MOSFET and IGBT drivers, motor drivers and more. These integrated solutions reduce the design cycle and ST's eDesignSuite allows you to rapidly select and simulate the optimal configuration for your power management design, bringing a further advantage in time-to-market.

eDesignSuite

SMPS DC/DC

SMPS AC/DC

LED DC/DC

LED AC/DC

PHOTOVOLTAIC

BATT. CHARGER

SMPS DC/DC

Input

Volt. Min [V] Volt. Max [V]

Output

Output Power:

Voltage [V]
Current [A]

+ -

START DESIGN

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Featured Products

VIPerPlus HV converters for rugged energy-saving SMPS
Feature standby power consumption <30 mW

LDCL015 series of capless ultra-low-drop linear regulators
150 mA output current, 50 mV dropout voltage

SPV1040 high-efficiency solar battery charger
Step-up DC-DC converter with embedded MPPT algorithm

Featured Videos All

eDesignSuite

37 Evaluation boards

The screenshot shows the STMicroelectronics website's 'Support' page. At the top, there's a navigation bar with links like 'Home', 'Products', 'Applications', 'Support', 'Sample & Buy', 'About', 'Contact', and 'My ST Login'. Below this, a 'Support' section is visible. On the left, a sidebar lists various support resources. The main content area features a table with 'Topic' and 'Action' columns. The 'Evaluation tools' row is circled in red. To the right, there are sections for 'Seminars' and 'Featured Videos'.

Support

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Support

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Tools and Software

STMicroelectronics is dedicated to your success when incorporating our products into your system. While we will strive to answer your question as rapidly as possible, we recommend that you first attempt to locate the answer on our web site using the following guide.

Topic	Action
Datasheets and application notes	Search specific documents in our technical literature page. To see all documents and files for a specific product, locate your device in the product catalog . Follow the link to the product folder/resources where all related documents can be found.
ST e2e communities	ST's forum pages full of useful ideas and information from other developers moderated by ST's application engineering teams
Frequently asked questions	FAQ pages organized by product type
Sales topics	For questions about product availability, pricing, where-to-buy, or other related issues, proceed to our sales support page.
Evaluation tools	To see how to design real-life applications using ST devices, you may download schematics and/or purchase evaluation boards on our evaluation boards selector page.
Development tools	To find the development tools you require to develop your application on your chosen silicon, visit our development tool pages
Software	To find the software development tools or firmware you require to develop your application on your chosen silicon, visit our

Seminars

13 May [SPC56 Automotive MCU Training](#)
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- Industry's first 650 V AEC-Q101 qualified MOSFETs in TO-247
- Dynamic NFC / RFID Tags in Healthcare Applications
- MEMS sensor HUB
- SPC5 32-bit MCU development ecosystem
- MEMS Microphones evaluation tools
- SPC56 32-bit automotive MCUs

38 Evaluation boards for LED Lighting

Resources

Documentation

Application Note (16)
Brochure (1)
Data Brief (60)
Datasheet (1)
Flyer (1)
User Manual (12)

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LED and General Lighting Solution Eval Boards

Part Number	Marketing Status	General Description	Tool Type	Core Product	Target Application
<input type="checkbox"/> EVAL6520-1421	<input type="checkbox"/> Active	<input type="checkbox"/> 14 W / 21 W T5...	<input type="checkbox"/> Evaluation Board	<input type="checkbox"/> -	<input type="checkbox"/> AC-DC Topologi
<input type="checkbox"/> EVAL6569	<input type="checkbox"/> NRND	<input type="checkbox"/> 18 W single-sta...	<input type="checkbox"/> Reference Design	<input type="checkbox"/> HVLED805	<input type="checkbox"/> DC-DC Topologi
<input type="checkbox"/> EVAL6574B	<input type="checkbox"/> Preview	<input type="checkbox"/> 185 W power s...	<input type="checkbox"/> Starter Kit	<input type="checkbox"/> HVLED815PF	<input type="checkbox"/> Display and Mo.
<input type="checkbox"/> EVALHVLED805		<input type="checkbox"/> 2 x 28 W electr...		<input type="checkbox"/> L6382D5	<input type="checkbox"/> DVD
<input type="checkbox"/> EVL130W-STRL...		<input type="checkbox"/> 2 x 58 W high f...		<input type="checkbox"/> L6520	<input type="checkbox"/> Fluorescent Lig.

Products : 63 |

Part Number	Marketing Status	General Description	Tool Type	Core Product	Target Application
EVAL6520-1421	Active	14 W / 21 W T5 miniature ballast dr...	Starter Kit	L6520	Fluorescent Lighting
EVAL6569	Active	L6569 High Voltage Half Bridge Driv...	Starter Kit	L6569	Fluorescent Lighting
EVAL6574B	Active	L6574 CFL/TL Ballast Driver Prehea...	Starter Kit	L6574	Fluorescent Lighting
EVALHVLED805	Active	HVLED805 evaluation board: insula...	Starter Kit	HVLED805	LED Lighting
EVL130W-STRLIG	Active	48 V - 130 W high efficiency conver...	Reference Design	L6562AT, L6599AT	AC-DC Topologies;LED I
EVL185W-LEDTV	Active	185 W power supply with PFC and s...	Reference Design	L6564, L6599A, VIPER27L	AC-DC Topologies;LED I
EVL6562A-LED	Active	Constant current inverse buck LED...	Reference Design	L6562A	AC-DC Topologies;LED I
STEVAL-CLP001...	Active	Demonstration board for PMOLED di...	Starter Kit	STOD2540PUR	DC-DC Topologies;LED I
STEVAL-ILB005...	NRND	Demonstration board for the L6585...	Starter Kit	L6585DE	Fluorescent Lighting
STEVAL-ILB007...	Active	2 x 58 W wide-range ballast based...	Starter Kit	L6585DE	Fluorescent Lighting
STEVAL-ILB008...	NRND	4 x 18 W wide-range ballast based...	Starter Kit	L6585DE	Fluorescent Lighting
STEVAL-ILB009...	Active	2 x 28 W electronic ballast with acti...	Starter Kit	STD3N62K3; STD845DN4...	Fluorescent Lighting
STEVAL-ILB010...	Active	2 x 58 W high frequency ballast for...	Starter Kit	L6562A; L6569; STL13N...	Fluorescent Lighting
STEVAL-ILD003...	Active	Analog wall dimmer for CFL/LED la...	Starter Kit	TS820	Fluorescent Lighting;LEI
STEVAL-ILD003...	Active	Analog wall dimmer for CFL/LED la...	Starter Kit	TS820	Fluorescent Lighting;LEI
STEVAL-ILD004...	Preview	Digital wall dimmer for halogen and...	Starter Kit	TS820-600FP; STGF10NC...	Light Dimmer
STEVAL-ILH004...	Active	70 W electronic ballast for metal ha...	Starter Kit	L6382D5; ST7FLITE49K2	HID Lighting
STEVAL-ILL003...	Active	HB LED without Diagnostic (32 Led)...	Starter Kit	ST7FLITE09Y0M6;STP16C...	LED Lighting
STEVAL-ILL009...	Active	OSRAM Golden DRAGON® LEDs bo...	Starter Kit	STLM20W87F	LED Lighting
STEVAL-ILL009...	Active	New RGB color demonstration boar...	Starter Kit	ST1S10PHR; ST7FLITE09...	LED Lighting

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